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Improving the usability of faceted exploratory search tools

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ABSTRACT

For some years now, the faceted exploratory search has faced tremendous challenges to devise a simple, instantly understandable, and usable user interface to explore the vast amount of data and information available on the Internet. In our previous research, we have indicated certain burdens with some of the existing approaches. Therefore, in this research, we are trying to uncover the attributes that influence users to use the faceted feature of the exploratory search technique. In this paper, we presented several key elements of existing search engine systems, the best of their major features were explored, and guidelines that will help to improve the usability of faceted exploratory search have been suggested and offers a further understanding of the fundamental characteristics of the faceted search, which shows the motivations to use the search, also presented the main parts of a pluggable search system.

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1. INTRODUCTION

In information retrieval and information seeking fields, exploratory search (SE) plays an important role in various domains from education and academia to industry and manufacturing. Exploratory search, originally, is a technique unknowingly used by individuals who are trying to explore new domains/fields or seeking information on the Internet about concepts that are unknown to them. In many cases, Internet surfers are tending to find answers to daily life questions, hacks, and new concepts by providing questions-like queries to the search engines. Therefore, How-To-websites are becoming common these days. However, the growth in the number of results obtained from regular search engines is impressively increasing day by day, leaving the users overwhelmed with an extensive amount of both valuable and useless results. To this end, researchers and search engine providers have considered this problem and tried to propose systems that can help to present better and quick answers to the information seekers. However, the huge amount of data available has presented a great challenge to implement and deploy a suitable mechanism that serves the main purpose of the exploratory search approach and efficiently deliver relevant results.

Generally, in order to achieve an efficient mechanism, three main elements should be considered and carefully designed, namely; information retrieval, information processing, and information presentation (Figure 1). All these three elements should be integrated in order to have a fully functional search engine [1], [2]. The first two elements have been covered in our previous publications [3]. Thus, this paper focuses on the third and most important element: information presentation. From the information presentation perspective, category-style options (i.e. faceted) that are presented to information seekers have received great acceptance among many users as reported on many occasions [4].

Faceted search (FS) is a unique feature in modern exploratory search solutions, and it tends to assist information seekers in discovering concepts of interest within the vast amount of results obtained from search engines [5]. It allows information seekers to discover keywords related to their field-of-interest, which will help in refining the obtained results and improve the search query as well as improve the vocabulary of the information seekers. The main limitation with faceted search is the proper presentation of the results. Designing and implementing a user-friendly interface plays a major role in the usability of the technology. Additionally, because faceted search allows navigation along several independent dimensions, therefore, careful considerations should be practiced and implemented. As a result, a large number of faceted search implementations lack proper representation leaving the user confused, not aware of how to proceed, and, in many cases, diverted from the main concept. In this paper, we will analyze how paying careful attention to the interface can ultimately enhance the relevance of a search. Initially, we will discuss the general guidelines for designing the user interface. Section 2 of this paper will describe the methodology followed in this research; Section 3 presents our findings. The discussion and conclusions are presented in Section 4.

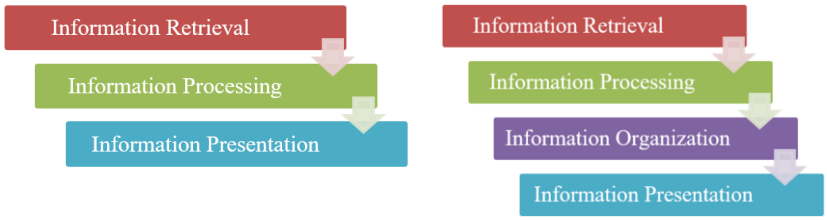

Figure 1. Search engine activity framework: (a) traditional search engines and (b) search engine with faceted feature

2. RESEARCH METHOD

Faceted search is considered an effective approach in refining the search results; it works based on confining and presenting the results that only match some given criteria, called facets. Facets are extracted from the metadata of the obtained results. Therefore, the faceted search applies another layer of information organization between the processing and presentation elements of the search engine activity framework, as illustrated in Figure 1. Technically, faceted search is considered as guided navigation via dynamically generated keywords from the obtained results. The keywords are generated by clustering the results into categories and are used to let the users drill into the obtained results in a structural manner as illustrated in Figure 2. The figure demonstrates the "meaning" feature of the DuckDuckGo search engine. This feature provides keywords related to the search topic to help the information seeking in finding more details about the concept in the query [6]. For example, based on the results presented by DuckDuckGo we can notice that the word "papers" can refer to scholarly papers, term papers, legal instructions, and banknotes as well as the reference management software, papers. Each keyword takes the user to more refined results based on the intended search goal [7].

Another approach of faceted search is through the use of dynamic HTML controls (i.e. checkboxes and drop-down menus) to help users to refine the results based on some attributes of the item retrieved by the search query. Many e-commerce web applications, reservations, and booking, as well as many digital libraries, utilize this approach. For example, when submitting a search query in Science Direct, the information presentation module will provide the options to refine the results based on publication year, article type, publication title, and subject area [8]. These options are dynamically changing based on the keyword submitted to the web application. Similarly, by searching for a laptop on Amazon.com the user can refine the results based on the brand, price, operating system, display size, type of processor, amount of memory, hard disk size, and customer review among many filters.

Two critical problems associated with faceted exploratory search can be highlighted 1) the enormous number of results and 2) the inadequate technique of organizing the related outputs from the unrelated ones. The process through which the search tool sorts results lies in its user interface. The interface of the user is a product controlling and presenting the data input by a user to manage the documents in the SE, which can present the documents return to the researcher. Revision to the user interface of SE is uncomplicated to impact and are possibly the most helpful to researchers [9]. The area of discovering difficult information on the web is huge [10]. A paper released in 2016 reported that the web had roughly more than 3 billion data, most of which were received by the Google search engine. In these queries, nearly all the users go through only the first-page outputs to their query [11].

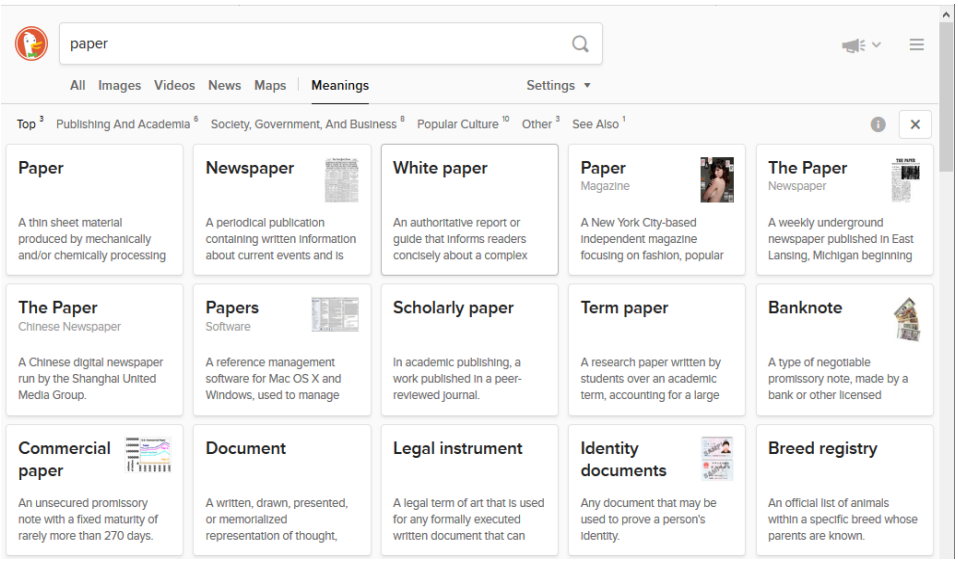

Figure 2. An example of faceted search results

Ruotsalo, *et al*. [12] analyzed the insufficient total number of related outputs by discovering the effectiveness of keyword vagueness on the results. The assumption states that keywords that are less vagueness retrieved more relevant results. Moreover, he analyzed the incomplete organizing of the outcomes by discovering the threefold of organizing results. His assumption argues that a useful way of organizing outcomes is one related to the structure of the wanted data.

Tvarožek [13] examines different semantic and syntactic facets from the applicant program aspect performed as a world wide web (www)-based tool multi-faceted interactive exploration (MFIE). A feature location approach used multi-faceted interactive tools analysis, is proposed in this paper. The authors focused on how the attributes location practice of their prototype can be enhanced with a multi-faceted interactive discovering procedure. Thus, they suggest for future work to discover more complex methods for making more ideal facets. Sonntag and Profitlich [14] authors focused on the FS framework based on cloud computing platforms with OLAP keywords on XML data warehouses a method positioning map for presenting FS in business intelligence designed on cloud computing is proposed. The authors also highlight that with the assist of facets, the business intelligence researcher can define describe keywords and rapidly determine the most applicable views of XML desired to produce the dashboards.

Radhakrishnan and Madhav [15] discussed the key features of effective ES systems. They investigated the capability of users to refine their queries and search results as fast as possible also highlighted the importance of visually representing big data and for representing the number of resources available per facet resource count. They also explored the use of rapid visual tools, such as sliders and filter widgets, to view the search results and proposed some dynamic queries that can help users develop hypotheses and discover information across multiple dimensions. The required labels of the hierarchical FS system are arranged in a method type to examine the approach related to the domain [16], [17].

2.1. Information visualization for search

In the faceted search, the researcher is clearly stated to search in the collection of data. Most SEs, however, are considered as features of a fixed interaction mode. SE results are usually depicted as a list of minimum-to-minimal interactions, for example, sorting or paging. Multiple modes of interaction are necessary for a new understanding of the data. A new understanding of data requires multiple modes of interaction. According to Bergamaschi, *et al*. [18], user control and responsibilities are to advance with ES systems. This characteristic should allow the user to designate how the data will be interpreted according to the task. In this section, we are, therefore moving beyond traditional facet searches and examining how information visualization can be used to increase the exploratory user experience.

2.2. Faceted search

In the digital online environment, faceted search follows conventional facet theory. It is the grouping of free, non-structured, faceted text. FS applications were considered with an impeccable mix of searching and keyword searches according to Qureshi and Greene [19]. This allows searchers to access

information more quickly and more flexibly, based on what they remember about why they are searching. Faceted interfaces help system explorers not to be lost in many SEs provide faceted navigation or browsing technique [20]. Interactive searching requires interactive filters to be used in several steps of data discovery. This means that the results are displayed to the search engine that has the prerogative to produce additional filters or modify current filters when a filter is created. The power of FS lies in users' ability to create their navigation by combining different perceptions instead of constraining them via a definite path. FS enables the object to be explored multidimensional. Ironically, even though keyword searches usually turn up a list of results, users in FS can customize their results by advertising one or more of their chosen advantages [21]. In search of certain data, the existing faceted navigation models have allowed searchers to limit themselves to a subject. However, one disadvantage is that searchers are likely to be presented with a very 'limited' search problem [22].

3. RESULTS AND ANALYSIS

Shneiderman [23] described eight "golden rules" or design principles that would apply to most interacting systems. In a seminal paper, Feng, *et al*. [24] applied those rules to the design of textual search database systems. We have reviewed those guidelines in the context of the web user interface design.

The first design principle consists of striving for consistency. Providing users with an interface that is consistent with its appearance and features is essential. Although not always achievable, aiming toward consistency throughout the search interface provides the user with a positive, non-frustrating, and easy to learn and repeat experience. This principle reinforces user trust in the system, given that all the interacting elements are placed where they are expected to be.

The sixth design guideline consists of permitting an easy reversal of actions. This guideline ensures that no action is final and that a means of undoing previous actions is available. An interesting example, although not in the context of search, is the recent releases of a means of undoing "send" of Google's Gmail, after hitting the "send" button, a user is provided with a few seconds to undo this action, which will prevent the email from being sent Figure 3. The second design guideline consists of providing shortcuts and query prompts for users based on their skill levels. For less experienced users, providing a prompt query response for clarifications can expedite the attainment of the desired results. By contrast, expert users can more precisely specify their query by using advanced operators from the beginning.

The third design guideline consists of offering informative feedback to users. For example, providing immediate search results can assist a user in deciding if the search is headed in the right direction (Figure 3). Even a limited number of results can significantly help a user [25]. Another example is highlighting the query terms within each summary of the search results [26].

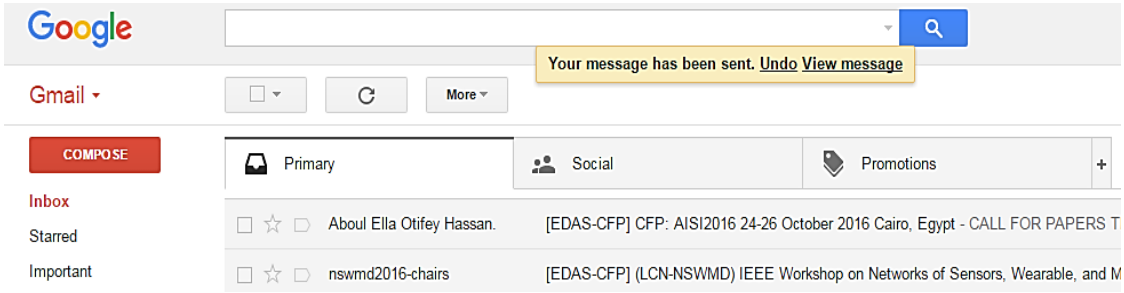

Figure 3. Gmail lab plugin

The fourth guideline, which is related to providing informative feedback in the context of search interfaces, consists of designing for closure. It aims to provide a user with a clear statement that his/her intended action has been completed. For example, the search page should list not only the results but also the performed query along with a count of the maximum number of returned results. This guideline provides a sense of satisfaction, relief, and prepares the user for his/her subsequent actions. The fifth principle consists of reducing user errors. The most frequently encountered errors are spelling and typographical mistakes. Besides, vocabulary issues can make queries unsuccessful. Another error-handling issue is related to the generation of an empty result set. To eliminate the likelihood of falling into such a problem, a suitable user interface can be designed that provide estimations of results for various queries [27], [28].

The seventh design guideline assures that the designer should always consider the trade-off between opaque functionality and transparent functionality. The balance involves choosing the extent to which the system anticipates the needs of a user (opaque operations) versus one that increases user control over the behavior of the interface (transparent operation). For example, Google News provides a good balance between opaqueness and transparency of its underlying personalization algorithm, as illustrated in Figure 4. Through a set of sliders on the right side of the web page (highlighted), a user can specify the degree to which a topic of interest weighs in the main news feed. By default, each topic has equal weights.

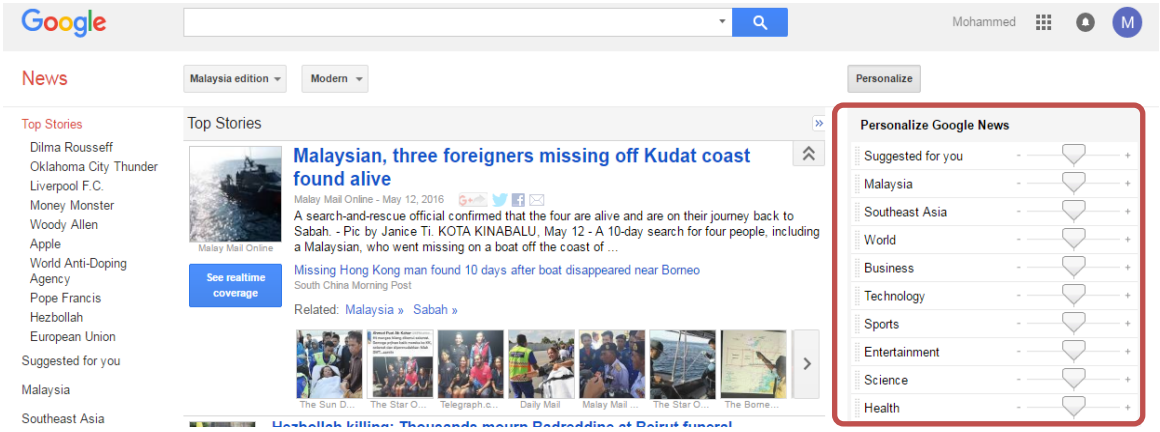

Figure 4. User can modify a particular topic by personalized feed

The eighth design guideline reduces user short-term memory load. Teevan, *et al*. [29] discussed that over a year, 40% of search views were on pages previously searched. Approximately 71% of users adopt the same previously used query string. This behavior will hint toward providing a history mechanism as well as favorite shortcuts. At present, most browsers provide a means of searching and managing search history, as shown in Figure 5.

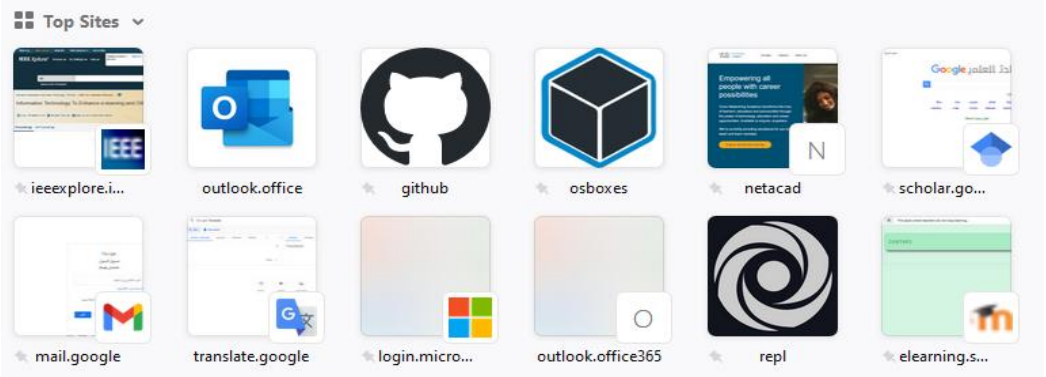

Figure 5. The frequently visited websites listed on the home screen

3.1. Aesthetic design and small details

Even though the appeared layout suggestions are effective, paying interest to details makes a novel difference between successful and failed interfaces. The amount of space visually showed to a researcher in a query box, for example, could often influence the length of the keyword. Researchers who could see a wide entry field are encouraged to type long keywords [30]. Aesthetics plays a major role in the searcher layout experience. This impression building by the presents of a layout is likely correlating with the searcher impression of its quality, as well as user satisfaction. Even though they give searchers a good response of related, outputs with aesthetic layout are often less effective than those with simple design [31].

3.2. Presenting the search results

A typical SE result page (SERP) is a list of information that summarises the retrieved documents (Figure 6). Each result typically contains the title of the document, as well as a set of important metadata. This combination of information is often named the "document surrogate".

3.3. Document surrogates

A surrogate should genuinely reflect the content of the document. Research suggests that query keywords should present within a document surrogate [32]. The relationship of query keywords within the retrieved document should also be emphasized. If query terms appear in the title, then they do not need to appear in summary. The source (i.e., uniform resource locators (URL)) should be concise and should stress the relationship with the user query. All the factors mentioned above and elements affect the likelihood that the user will select the retrieved document for further exploration. In the next subsection, we delve into summaries that are included within a document surrogate.

3.4. Summaries

The document summaries used by traditional search engines are unlike those used in the abstract of a research paper. In general, summaries are not intended to inform the researcher about the main topics of the information. Instead, they are meant to display fragments of sentences that show how the query terms are used within the document and how they present concerning one another. Subsequently, query keywords are frequently according to as keyword-in-context (KWIC) and summaries as query-based summaries [33].

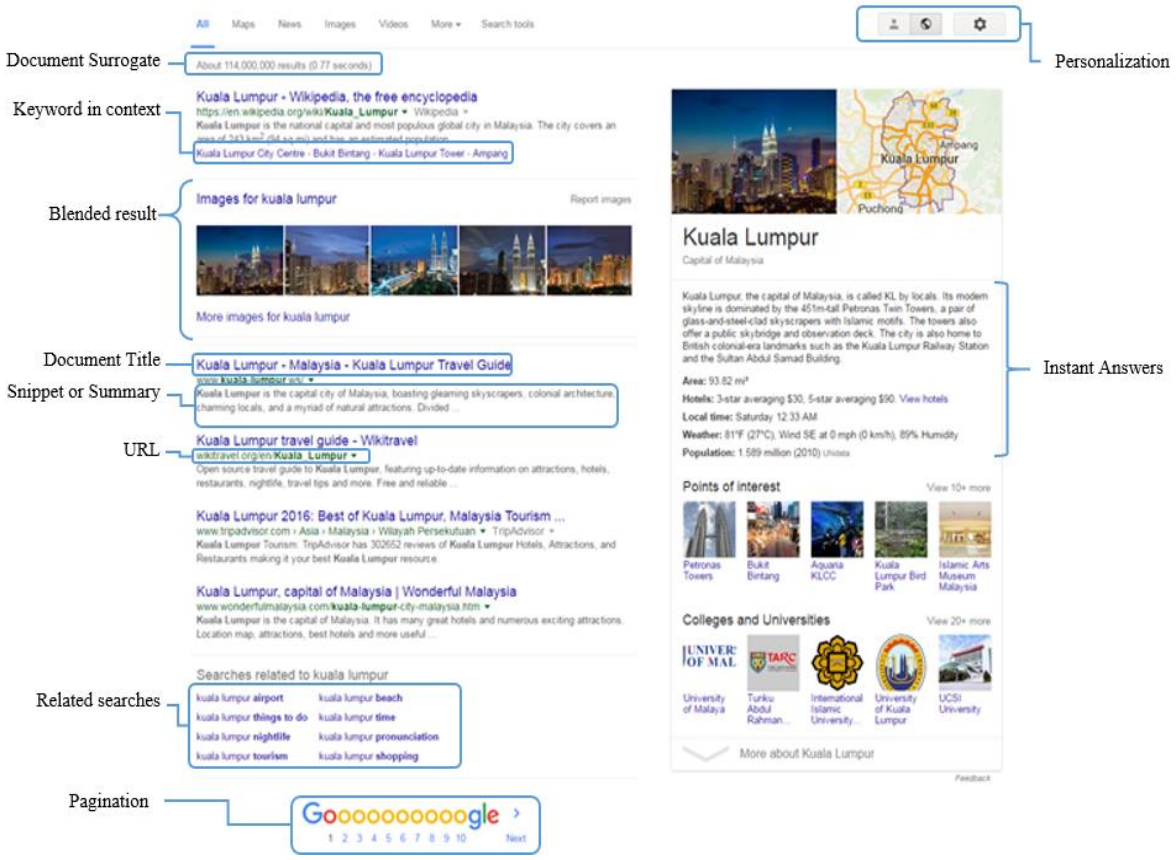

Figure 6. Google's search engine result page (SERP)

Ravana, *et al*. [34] showed that search engines with query-based summaries would be more effective than systems that only provided the first sentences of the retrieved document. Their study also showed that participants opened fewer full-text articles with query-based summaries than without, and thus, less relevant results would be effectively disregarded.

In another study on summaries, Babekr, *et al*. [35] found that given three choices for viewing summaries, the definite preference was for an instant view, in which clicking would expand the document

summary to present additional information. The majority of the participants generated faster and more accurate results through an instant view. Concerning the length of a summary, Netto, *et al*. [36] determined that length is generally query-dependent. If the query involves finding the answer to known facts, then a one-sentence summary is preferred. However, for more exploratory queries, a paragraph is usually preferred even if such a choice will require the user to scroll down the page further.

3.5. Query terms

Highlighting query terms aims to draw user attention to the parts of information that are most likely related to the query. This method helps researchers see how close each query term is concerning one another. The proximity of query terms is a strong indicator of relevance [37]. Highlighting query terms either within summaries or within the entire retrieved document has been demonstrated to be a useful feature.

3.6. Additional features

Aside from document surrogates, additional features have been found useful in search engine listings. These features include infinite scrolling, possible previews of document content, the blending of results from different verticals, and shortcuts. No standard number of results to be displayed per page has yet been determined. Traditional web search engines typically show between 10 and 30 results per page. Recently, search engines, such as DuckDuckGo (duckduckgo.com), are featuring infinite scrolling which is shown in Figure 7. This option provides a good trade-off between showing a few results and providing more if the user is interested in scrolling down the page [38].

Other approaches show a preview of a document within the results page. The customary approach consists of allowing the user to click on a document title or an adjacent icon to see more information. This approach has been adopted by the Bing (www.bing.com) search engine Figure 8. When a query is ambiguous, the general approach used by most mainstream web search engines is to provide diverse results. A particularly efficient approach involves prompting a user to refine further his/her query like that of Google's "Did you mean?" feature. This feature can be particularly helpful when a query has several commonly understood but different definitions. Blending query search results and media types is a recent trend among search engine providers see Figure 8.

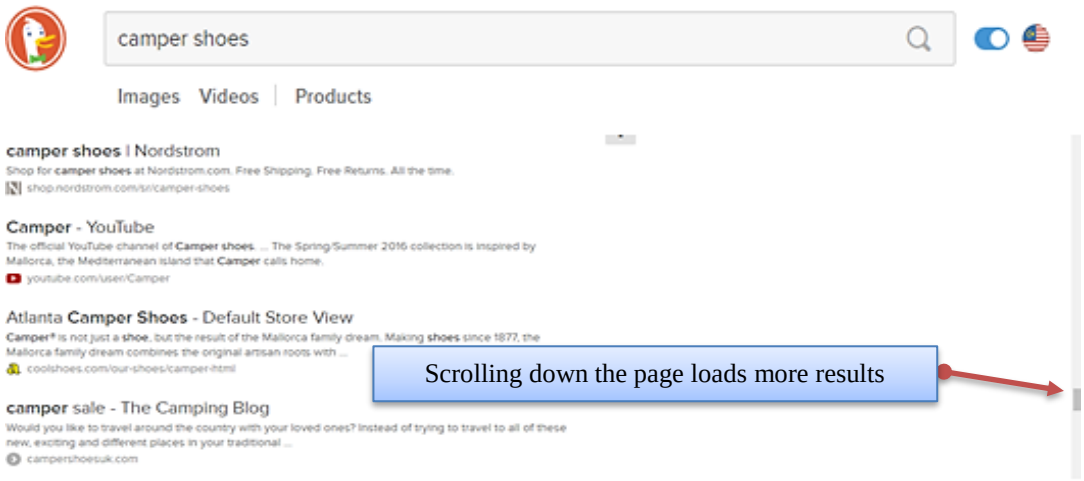

Figure 7. Scrolling down the page on duckduck go shows more results

3.7. Importance of sorting

Search results are frequently sorted according to highly tested and closely guarded algorithms. As an alternative, search results may be sorted based on clearly defined metadata fields. As previously noted, users tendon look at the first results and rarely looked beyond the first page [39]. In an interesting twist on this user characteristic, reversed the order of the listing. The participants became aware of the reversal and began to spend more time looking at the bottom of the page. This finding can suggest that users will spend a brief amount of time scanning the relevance of the results. Once they are aware of the relevance-ranking pattern used by the search engine, users will work the system out to get the results they need.

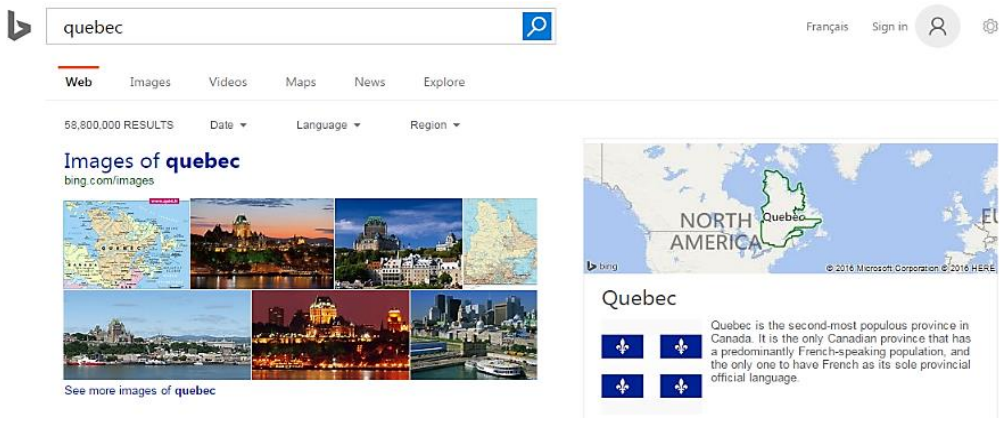

Figure 8. More information about the website in the quick preview pane

3.8. Faceted exploratory search system design

The relation browser features an interesting option, which allows the user to change search views. We have reviewed multitudinous views that can be chosen from the search results, views that can be used on the facets, which can easily be adapted to search [40], [41]. Figure 9 presents the main parts of a pluggable search system. The first part consists of a repository of shared datasets, which can take the form of a social website. Users can upload datasets for community comments, votes, or further editing. One important aspect is to allow users to describe the datasets by specifying the type of each field. The other part takes the form of another social site, in which datasets are replaced by widgets, which are pluggable elements used to build a search interface and its functions. The previous section detailed some of these widgets for the query terms, search results, or facets. These widgets can then be uploaded to the site for others to use or to socialize on. The last part takes the form of a web application from which a designer can drag and drop different widgets to create the interface.

The designer can first choose a dataset of interest and a layout for the interface (facets on the left, right, or top), then populate it with widgets. After the designer has created the interface, he can then submit it to yet another social site (or section of the same site). This can take the form of a gallery of interfaces created to explore certain parts of the uploaded datasets.

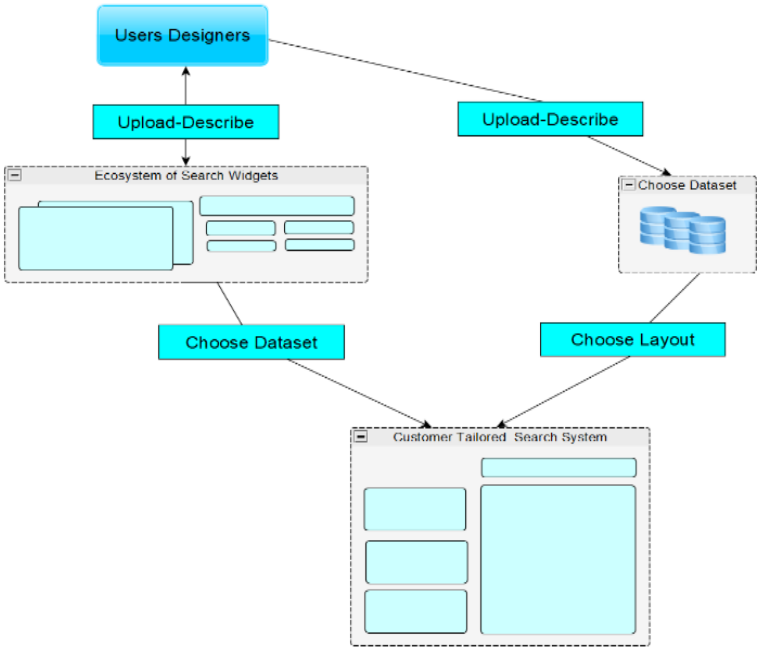

Figure 9. A pipeline to build a faceted exploratory search system

4. DISCUSSION AND CONCLUSION

In this article, the descriptive faceted search model has been analyzed, and the progression of its techniques including the removal of facet word, the major problem with current SEs is that they create crucial to replace the replication standard. The ideal model of the process is to evaluate dataset volume and update regularity, additionally query load, and use these to calculate the desired scales of replication wildly. If these specifications require changing, the system is productively "restarted" with the new specification. An acceptable solution should be capable to revise to changing workloads efficiently. Faceted search provides a more dynamic means to browse and search for resources than the traditional "advanced search form", where all the available search fields are delivered at once. This paper has also highlighted many potential studies that can be undertaken including automated faceted taxonomic design and visualization, significance assessment for FS outcomes, faceted design. Traditionally, users have to set up the search criteria at the beginning of the search. However, users may not be completely clear about the keywords in all the dimensions when they initiate the search, and thus, the traditional search is unsuitable for typical inquiries. Consequently, structured properties may increase to an extremely large number, which leads to a challenging search task and a loss of search focus. In this paper, we presented several key elements of existing search engine systems, the best of their major features were explored, and guidelines that will help to improve the usability of faceted exploratory search have been suggested and offers a further understanding of the fundamental characteristics of the faceted search, which shows the motivations to use the search, also presented the main parts of a pluggable search system.

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